1. An inductor alternator flywheel system comprising:

a rotatable member mounted on bearings for rotation about an axis, said member including a flywheel rotor with a hollow center and an inwardly facing radial surface forming a plurality of protrusions extending radially inwardly;

a non-rotating member having a source of homopolar flux, said flux creating magnetic poles in said protrusions;

at least one cylinder having an outer radial surface, said cylinder being mounted concentric with respect to said rotor and spaced apart radially from said protrusions such that an armature air gap is formed between said protrusions and said outer surface, said cylinder being constructed of substantially high permeability material; and

at least one armature coil mounted within said air gap such that said flux induces an alternating voltage in said armature coil when said rotor rotates about said axis.

2. An inductor alternator flywheel system as described in claim 1 wherein:

said flywheel rotor is constructed of steel.

3. An inductor alternator flywheel system as described in claim 2 wherein:

said flywheel rotor has a central hole having a bore surface to which a hub portion is connected for mounting said flywheel to a central portion containing a bearing for journaling said flywheel rotor;

said hub portion is constructed such that it provides a high reluctance magnetic path between said flywheel rotor and said center portion.

4. An inductor alternator flywheel system as described in claim 3 wherein:

said hub portion is constructed from a non-ferromagnetic material.

5. An inductor alternator flywheel system as described in claim 1 wherein:

said flywheel rotor is a hollow cylinder.

6. An inductor alternator flywheel system as described in claim 1 wherein:

said inwardly extending protrusions are formed in a liner that is radially inside said hollow portion of said flywheel rotor.

7. An inductor alternator flywheel system as described in claim 6 wherein:
said liner is interference assembled inside said hollow portion of said flywheel rotor.

8. An inductor alternator flywheel system as described in claim 6 wherein:
said liner is constructed from multiple axial layers that reduce eddy currents in said intrusions.

9. An inductor alternator flywheel system as described in claim 8 wherein:
said liner is comprised of laminations.

10. An inductor alternator flywheel system as described in claim 8 wherein:
said liner has a lower maximum hoop direction stress than said flywheel rotor hollow portion when said flywheel rotor is rotating at normal operating speed.

11. An inductor alternator flywheel system as described in claim 1 wherein:
said flywheel is connected to at least one hub having a smaller inner diameter, said inductor alternator flywheel further including a pair of upper and lower mechanical bearings for providing rotational support of said rotor, and an electromagnet mounted with respect to said flywheel rotor such that said electromagnet, when energized, lifts a majority of the weight of said flywheel rotor from said mechanical bearings.

12. An inductor alternator flywheel system as described in claim 11 wherein:
said electromagnet acts directly on said flywheel rotor to remove a majority of the weight of said flywheel rotor from said mechanical bearings.

13. An inductor alternator flywheel system as described in claim 1 wherein:

said source of homopolar flux comprises at least one field coil that induces said flux to flow.

14. An inductor alternator flywheel system as described in claim 13, further comprising:

a stationary yoke made of material having low magnetic reluctance, said yoke having an outer radial portion, an inner radial portion, and an intermediate portion between said outer radial portion and said inner radial portion;

said intermediate portion of said yoke having surfaces that are closely coupled magnetically with said field coil;

said outer radial portion of said yoke having a pole with axially facing surfaces closely spaced from said flywheel;

said inner radial portion of said yoke having surfaces that are operatively closely linked magnetically with said cylinder;

whereby said yoke, said flywheel, and said cylinder form a low reluctance magnetic circuit with said airgap between said flywheel and said cylinder, and said field coil drives flux through said magnetic circuit.

15. An inductor alternator flywheel system as described in claim 1 wherein:

said cylinder is constructed of multiple axial layers that reduce eddy currents in outer surface of said cylinder.

16. An inductor alternator flywheel system as described in claim 15 wherein:

said cylinder is comprised of laminations.

17. An inductor alternator flywheel system as described in claim 16 wherein:

said laminations have a central hole and the inner diameter of said laminations is connected to a central shaft.

18. An inductor alternator flywheel system as described in claim 16 wherein:

said central shaft is constructed of substantially high permeability material.

19. An apparatus for providing emergency power in the event of disruption in power from a primary power source coupled to an output, said apparatus comprising:

a rotatable mass that stores kinetic energy;

a brushless generator having a pair output leads, said leads being coupled to said output, and at least one field coil, said generator being coupled to said rotatable mass such that kinetic energy from said mass is converted to electrical energy and delivered to said leads when said field coil is energized;

said field coil being sufficiently energized when said primary power source is operational such that loss of said power does not require a rapid increase in power to said field coil to prevent a period of disruption in output power; and

a monitoring system that monitors the rotational speed and automatically increases the drive signal to said field coil to maintain a substantially constant output voltage at said output as said generator speed decreases.

20. An apparatus as described in claim 19 wherein:

said generator is an inductor alternator with both rotor and stator comprising laminated constructions.

21. An apparatus for providing emergency power in the event of disruption in power from a primary power source coupled to an output, said apparatus comprising:

a rotatable mass that stores kinetic energy;

a brushless motor/generator having a pair output leads, said leads being coupled to said output, and at least one field coil, said motor/generator being coupled to said rotatable mass such that kinetic energy from said mass is converted to electrical energy and delivered to said leads when said field coil is energized; and

said brushless motor/generator also having multiphase armature coils from which said motor/generator is accelerated to normal operating speed by supply of AC power to said multiphase armature coils and is kept from accelerating above normal operating speed by reducing said AC power to said armature coils;

a field control mechanism increases power to said field coil to maintain a substantially constant voltage as the speed of said generator decreases.

a field controller that provides sufficient power to said field coil such that said output voltage does not drop appreciably during an interruption of said primary power without reduction in rotational speed of said motor/generator, and said field control mechanism further increases power to said field coil to maintain a substantially constant output voltage at said output as said generator speed decreases.

22. An apparatus as described in claim 21 wherein:

the rotor portion of said motor/generator comprises multiple axial layer construction to reduce internal eddy current generation.

23. A method for providing emergency power in the event of a disruption in power from a primary power source coupled to an output, said method comprising the steps of:

storing kinetic energy in a rotatable mass by rotating said mass about an axis with a motor, said power to the armature coils of said motor being controlled to control the speed of said rotatable mass;

coupling said mass to a brushless generator, said generator having a pair of output leads, said leads being coupled to said output, and at least one field coil such that kinetic energy from said mass is converted to electrical energy and delivered to said leads when said field coil is energized; and

increasing power to said field coil when the speed of said generator decreases to maintain a substantially constant output voltage at said output during an interruption.

24. A method as described in claim 23 wherein;

said field coil is substantially energized when said primary power is functioning such that power generated by the generator does not significantly drop when the primary power disrupted.

25. A method as described in claim 24 wherein;

said generator is an inductor alternator comprised of a rotor and a stator, said rotor has poles whereby said poles are constructed with a surface facing said stator that reduces eddy current generation in said poles.

26. A apparatus for converting between electrical and kinetic energy comprising:

a flywheel rotor comprising a hollow cylinder and a liner with intrusions extending therefrom and forming a radial air gap, said intrusions being constructed of ferromagnetic material;

a member that generates homopolar flux , said intrusions and said flux generating member forming a magnetic circuit having a total reluctance that remains substantially constant while said rotor is rotated about an axis; and

at least one stationary airgap armature coil mounted within said radial airgap with the active portion of said armature coil extends to substantially the entire axial length of said intrusions such that flux induces an AC voltage in said at least one armature coil when said rotor is rotated about said axis.

27. An apparatus as described in claim 26 wherein:

said hollow cylinder is comprised of an alloy steel having been quenched and tempered to a tensile yield strength greater than 100 ksi and a fracture toughness greater than 70 ksi(in)^1/2.

28. An apparatus as described in claim 27 wherein:

said hollow cylinder is constructed as a seamless ring by rolled ring forging.

29. An apparatus as described in claim 26 wherein:

said liner is constructed from multiple pieces around its circumference.

30. An inductor alternator flywheel system comprising:

a rotatable member that may be rotated about an axis, said member including a steel flywheel rotor having a plurality of poles;

a non-rotating member that generates homopolar flux, said flux magnetizing said poles;

a stator having an air gap facing surface, said stator being mounted concentric with respect to said rotor such that an armature air gap is formed between said poles and said air gap facing surface, said stator being constructed of substantially high permeability material; and

at least one armature coil mounted within said air gap such that said flux induces an AC voltage in said at least one armature coil when said rotated about said axis;

said flywheel rotor being supported for rotation about a substantially vertical axis by a full levitation magnetic bearing system comprising at least one axial magnetic bearing carrying the axial weight and at least two radial magnetic bearings providing radial support.

31. An inductor alternator flywheel system as described in claim 30 wherein:

said non-rotating member generating homopolar flux contains at least two field coils that generate flux across an upper and a lower axial air gap to said flywheel rotor;

a position sensor determines the axial position of said rotor with respect to said non-rotating member;

power to said field coils are actively controlled using information from said position sensor to form said axial magnetic bearing.

32. An inductor alternator as described in claim 31 wherein:

increasing power to both coils increases the voltage induced in said armature coils, and increasing power to one field coil with respect to the other moves the flywheel vertically in one direction.

33. An inductor alternator flywheel system comprising:

a rotatable member mounted for rotation about an axis, said member including a steel flywheel rotor with a hollow portion having a laminated liner with a plurality of intrusions extending therefrom to a minimum radius;

a non-rotating member that generates flux, said flux creating magnetic poles in said intrusions;

at least one cylinder having an outer surface comprised of laminations, said cylinder being mounted concentric with respect to said rotor such that an armature air gap is formed between

said intrusions and said outer surface, said cylinder being constructed of substantially high permeability material; and

at least one armature coil mounted within said air gap such that said flux induces an AC voltage in said at least one armature coil when said rotated about said axis.

34. An inductor alternator for a flywheel energy storage and retrieval system comprising:

a rotatable member that may be rotated about an axis, said rotatable member including a steel flywheel rotor with a hollow portion having a plurality of intrusions extending radially inwardly therefrom to a minimum radius;

a non-rotating member that generates homopolar flux, said flux creating magnetic poles in said intrusions;

a cylinder having an outer surface, said cylinder being mounted such that it rotates with said rotor such that an armature air gap is formed between said intrusions and said outer surface, said cylinder being constructed of substantially high permeability material; and

at least one armature coil mounted within said air gap such that said flux induces an AC voltage in said at least one armature coil when said rotated about said axis.

35. An inductor alternator flywheel system as described in claim 34 wherein:

said cylinder is attached to said rotor through the use of a high reluctance connection.

36. An inductor alternator flywheel system as described in claim 35 wherein:

said intrusions are constructed from multiple axial layers that minimize eddy currents in said intrusions.

37. An inductor alternator flywheel system comprising:

a rotatable member supported for rotation about a substantially vertical axis, said rotatable member including a flywheel rotor with a non-uniform surface such that variations in said surface form poles;

a non-rotating member having at least one field coil that generates homopolar flux, said flux traveling through said poles;

a stationary portion of said non-rotating member adjacent to and spaced apart from said poles for receiving said flux and defining an air gap between said stationary member and said poles;

at least one armature coil mounted within said air gap such that said flux induces an AC voltage in said armature coil when said rotor is rotated about said axis;

a full levitation magnetic bearing system for supporting said rotor for rotation about said vertical axis, said magnetic bearing system comprising an axial force generating magnetic bearing and upper and lower radial force generating magnetic bearings.

38. An inductor alternator flywheel system as described in claim 37 further comprising:

a position sensor for determining the axial position of said rotor to provide axial control; and

a magnetic circuit links said homopolar flux from said field coil and provides a bias flux for the axial magnetic bearing.

39. An apparatus for providing emergency power in the event of disruption in power from a primary power source coupled to an output, said apparatus comprising:

a rotatable mass that stores kinetic energy;

a brushless generator having a pair output leads, said leads being coupled to said output, and at least one field coil, said generator being coupled to said rotatable mass such that kinetic energy from said mass is converted to electrical energy and delivered to said leads when field power is applied to said field coil; and

a field controller that provides field power at a level to said field coil when said rotatable mass is rotating at normal full operating speed such that said generator provides full output power under full load to said output at the instant of disruption in primary power; and

said field controller increases said field power during a continuous disruption of primary power to maintain a substantially constant output voltage at said output as said generator speed decreases.

40. An apparatus for providing emergency power in the event of disruption in power from a primary power source coupled to an output, said apparatus comprising:

a mass supported on bearings for rotation to store kinetic energy;

a brushless motor/generator having a pair output leads, said leads being coupled to said output, and at least one field coil, said motor/generator being coupled to said rotatable mass such that kinetic energy from said mass is converted to electrical energy and delivered to said leads when said field coil is energized; and

said brushless motor/generator also having multiphase armature coils from which said motor/generator is accelerated to normal operating speed by supply of AC power to said multiphase armature coils and is kept from accelerating above normal operating speed by reducing said AC power to said armature coils;

said brushless motor/generator comprising laminated rotor and stator constructions providing high enough efficiency such that said field coil can be sufficiently energized such that the voltage generated by said armature coils remains substantially constant when primary power is disrupted;

a field control mechanism increases power to said field coil to maintain a substantially constant voltage as the speed of said generator decreases.

41. An inductor alternator flywheel system for converting between electrical and kinetic energy, said apparatus comprising:

an annular steel flywheel rotor with a hollow center bore and an attached internal liner inside said bore having inwardly extending radial protrusions and being constructed from multiple axial layers that reduce eddy current generation in said protrusions;

a source of homopolar flux that generates homopolar flux in a magnetic circuit that includes said flywheel rotor and at least one stationary armature coil mounted such that said flux induces an AC voltage in said armature coil when said rotor is rotated about an axis.